

The life cycle of the little known and endangered endemic Madeiran Brimstone Butterfly *Gonepteryx maderensis* Felder, 1862 (Pieridae)

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Abstract. *Gonepteryx maderensis* Felder, 1862 is an endemic Endangered Species of European Conservation Concern restricted to the humid laurel forest (humid *laurisilva*) of Madeira. It has not hitherto been well studied. The life cycle is described and illustrated for the first time based on a limited number of eggs (six) and larvae (four) collected from the wild. Data collected since 1932 show that this species is univoltine with the adults surviving for many months prior to mating and oviposition on the sole host-plant *Rhamnus glandulosa* Aiton (Rhamnaceae). Further study is necessary to underpin the conservation of this little-known species.

Resumo. O Pierídeo *Gonepteryx maderensis* Felder, 1862 é uma espécie endémica, considerada em risco e restringida à laurisilva húmida da Ilha da Madeira. O seu ciclo de vida, que não foi previamente bem estudado, é descrito e ilustrado pela primeira vez com base num número limitado de ovos (seis) e larvas (quatro), colhidas na natureza. Informação acumulada desde 1932 indicam que esta espécie é univoltina, com a sobrevivência dos adultos durante muitos meses antes do acasalamento e postura na sua única planta hospedeira, o sanguinho – *Rhamnus glandulosa* Aiton (Rhamnaceae). Estudos adicionais são necessários para garantir a conservação desta espécie pouco conhecida.

Introduction

The Madeiran brimstone butterfly *Gonepteryx maderensis* Felder, 1862 is a distinct species (Kudrna 1975; Brunton et al. 1996) endemic to the humid laurel forest (humid *laurisilva*; see Press & Short 1994) of Madeira Island, where it has been recorded flying mostly between 420 and 1800 m above sea level from March to September (Wakeham-Dawson et al. 2002). It has been classified as an Endangered Species of European Conservation Concern (van Swaay & Warren 1999) as it is limited to Madeira and specifically to the humid *laurisilva*, which is also of conservation concern and being re-established in a number of areas (Wakeham-Dawson & Warren 1998; Wakeham-Dawson et al. 2000). However, few studies have concentrated on the ecology of *G. maderensis*, making it a species about which little is known. As well as being isolated in Madeira, *G. maderensis* is not easy to study as the adult butterflies generally remain high in the *laurisilva* canopy. Occasionally, adults (males in particular) seek nectar from flowering plants closer to the ground (Wakeham-Dawson et al. 2000). Males may patrol over relatively large distances between areas of humid *laurisilva*, but females are more localised in their movements. Oviposition takes place on only one species of host-plant: Macaronesian Buckthorn *Rhamnus glandulosa* Aiton (Rhamnaceae). This tree is usually present as a component of the upper canopy, making observation and collection of eggs generally difficult (Wakeham-Dawson & Martin, unpublished obs.). However, *G. maderensis* eggs have also been observed on a young, low-growing wild *R. glandulosa* plant (Aguiar, unpublished obs.)

Manley & Allcard (1970) suspected *G. maderensis* to have two generations per year. However, Brunton et al. (1996) thought it could be univoltine with the adults surviving for many months prior to mating and oviposition. Unlike other *Gonepteryx* spp., neither sex of *G. maderensis* reflects ultra-violet (UV) light from the undersides of the wings (Brunton et al. 1996), perhaps giving a cryptic advantage against predators when the butterflies are roosting beneath similarly non-UV reflecting laurel leaves during long periods of unsuitable weather and/or diapause as adults.

The current paper describes the life cycle of *G. maderensis* in detail for the first time from a limited number (six eggs and four larvae collected from the wild) of captive-reared specimens and uses data from literature and field observations recorded between 1932 and 2009 to investigate the distribution and voltinism of this species. Results are discussed in relation to other *Gonepteryx* spp., but as these results are limited, several further questions are raised for future studies.

Material & methods

The life cycle of *G. maderensis* was observed in captivity from six eggs and four L1-larvae collected in June 2000 at two sites inside the *laurisilva* zone indicated below; note that the *laurisilva* at Chão da Ribeira is more pristine than at Chão dos Louros:

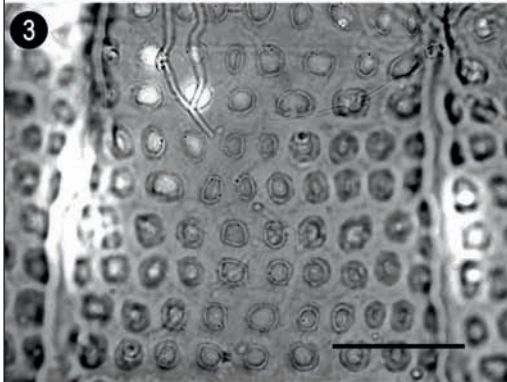
One egg collected at Chão dos Louros, slightly below the Encumeada Pass (UTM: 311490.45 m E; 3626166.21 m N), at an altitude of approximately 800 m on 19 June, and an L1-larva collected on 6 July 2000.

Five eggs collected deep in the Chão da Ribeira valley (UTM: 302377.14 m E; 3629812.45 m N) at approximately 500 m on 27 April and 8 June 2000. Three L1-larvae collected at the same locality on 8 and 28 June 2000.

The rearing was carried out in the laboratory at room temperature in two round plastic breeding cages. These were transparent cylinders 20 cm in diameter and 40 cm high, with base and lid of durable green polythene. One small potted plant of *Rhamnus glandulosa* was put inside each breeding cage to serve as a food source for the larvae. No particular light source was used other than the normal room artificial illumination by eight fluorescent tubes, which were turned on for at least seven hours daily. In addition, there was a source of natural daylight from the all-width windows of one of the room's walls.

Given the limited number of eggs and larvae observed in the study, results are presented as ranges, rather than means and standard deviations. Specimens were disturbed as little as possible to ensure survival through the complete life cycle and few measurements were taken. Future studies involving more eggs and larvae would allow more measurements to be taken for statistical analysis.

Figs 1–7. *Gonepteryx maderensis* immature stages. **1.** A singly laid egg on a fresh twig of *Rhamnus glandulosa*. **2.** The egg's chorion surface in detail. **3.** Microscopic preparation of an egg's chorion (scale bar = 0.21 mm). **4.** L1-larva with body length of 5 mm. Dorsal secreting hairs with droplets and protruding dark bases are clearly visible; these are closer together near the head and anal regions. **5.** L1-larva with body length of 5.6 mm; figure showing an even better view of the defensive droplets. **6.** Microscopic preparation of the L1-larva cephalic capsule (scale bar = 0.19 mm). **7.** L2-larva with a body length of 10 mm.



Description of the stages

Egg (n = 6): The eggs are laid singly on both surfaces and the margins of the young leaves, and sometimes twigs, of *Rhamnus glandulosa* (Fig. 1). Eggs are yellowish-white when freshly deposited, but become orange-yellow close to eclosion. Eggs have been found only from late April to July (also see Wakeham-Dawson & Aguiar 2003). The egg is cone-shaped and 1.45 to 1.50 mm in length from base to apex. It is 0.5 mm wide at the base, 0.65 to 0.70 mm at the maximum width and 0.28 mm wide at the apex (Fig. 2). The chorion is folded into nine vertical keels, which are separated by 0.19 mm wide furrows. The chorion's (egg case) surface is covered with microscopic nodules that are 15 by 8.8 μm in size (Fig. 3). At the egg's maximum width it is possible to observe 5 horizontal rows (each 97 μm in length) of 13 nodules. The micropyle is oval-shaped; dimensions: 0.28 by 0.21 μm . Sometimes the larvae partially eat the egg case after hatching.

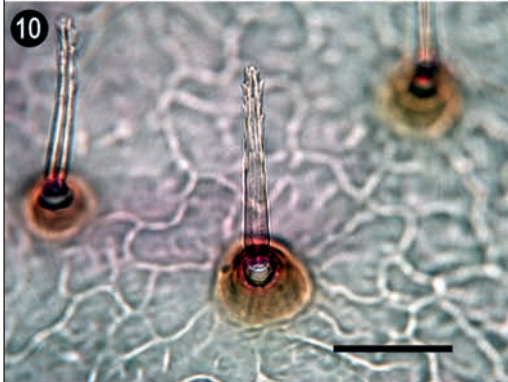
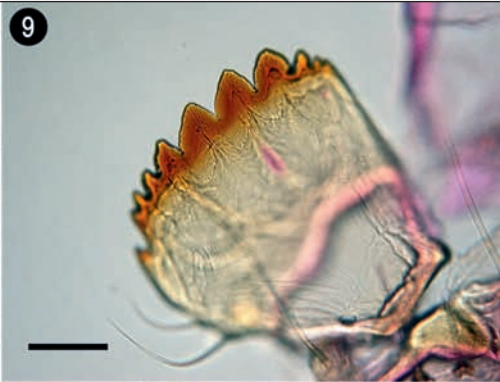
First instar larva (L1) (n = 10): This is yellowish-green with a length of 2 mm when freshly emerged from the egg. This stage lasts for five to seven days and when the first moult occurs the L1-larva is around 8 mm long. At this stage and during L2 (but less visibly during the other stages), the larva has a double row of erect dorsal glandular hairs that secrete tiny droplets of a clear, highly adhesive liquid.

Halfway through the L1 stage the secreting hairs are clearly visible inserted in dark bases along the dorsum of all body segments, but are most abundant near the head and on the last body segment (Figs 4, 5). During this and subsequent stages, the whole body becomes covered with a second type of small hair that also has a dark base. However, it is still possible to distinguish the secreting hairs from these smaller hairs as the secreting hairs are inserted in prominent tubercles. The larva at this stage has a very small cephalic capsule, with a width of 0.44 mm (Fig. 6).

Second instar larva (L2) (n = 10): This is yellowish-green, but with a more intense green colour than in L1. The L2 stage lasts for two to three days and the larva reaches a length of 12 mm by the time the second moult occurs (Fig. 7).

Third instar larva (L3) (n = 10): This is green with a narrow spiracular white stripe that runs along the whole length of the body (Fig. 8). The white stripe has a subtle white suffusion above it. The cephalic capsule is now almost 2 mm in width and the mandibles have developed many more cutting teeth (Fig. 9). The entire body and the cephalic capsule are covered with setae bearing tubercles (Fig. 10) that appear to be minute black dots to the naked eye and give the larva a 'velvety' appearance. The L3 stage is completed in three days and the larva attains a maximum length of 18 mm by the third moult.

Figs 8–15. *Gonepteryx maderensis* immature and adult stages. **8.** L3-larva with a body length of 14 mm. **9.** Microscopic preparation of an L3 mandible (scale bar = 0.17 mm). **10.** Microscopic preparation showing setae and dark tubercles in the cephalic capsule of an L3-larva (scale bar = 0.05 mm). **11.** L4-larva with a body length of 35 mm. **12.** Pupa hanging 'head-down' from a twig of the food plant. **13.** A male, just before leaving the pupa. The chrysalis has become transparent enough to show the characteristic bright orange of the male's fore-wings. **14.** Dorsal (d) and ventral (v) views of a set male. **15.** Dorsal (d) and ventral (v) views of a set female.



Fourth instar larva (L4) (n = 10): Similar to L3 stage larva, but the white suffusion above the white longitudinal stripe is more extended dorsally (Fig. 11). The L4-larva completes the fourth stage in five to six days and attains a maximum length of around 35 mm before pupating.

Larvae of *G. maderensis* are very sluggish during the day, but appear to be more active during the night when they feed. In all moults the larvae eat their shed skins. The only observed larval defensive behaviour involved the larvae falling from their host-plant and hanging suspended by a silk thread until the disturbance had ceased.

Pupa (n = 10): Just before pupating (pre-pupa stage) the larva suspends itself, 'head-down' from a twig or leaf by the cremaster and a silk thread around the body; the green colour becomes paler, the longitudinal white stripes disappear and the body inflates slightly making the individual segments more visible. The pupa has a length of 23–26 mm and this stage lasts for 11–12 days (Fig. 12).

Imago (n = 10): Just before eclosion the pupal tegument becomes transparent and it is very easy to see by the unexpanded wings' colour if the future imago will be a male or a female (Fig. 13).

In the male (Fig. 14), the dorsal surfaces of the fore-wings are bright orange (more intensely so in the discal-cellular area) turning yellow just before the external margin, with an indistinct orange spot in the discal cell. The costa and external margin are bordered by a fine brown line, which becomes darker at the terminal extremities of veins. The hind-wings are yellow with an orange spot in the discal cell. Small reddish-brown dots are present at the terminal extremities of the veins. The male has a wingspan of 52–57 mm.

The ventral surfaces of the wings are greenish-yellow with an orange tint in the fore-wings and a submarginal row of small brown spots on hind- and (less visibly) on the fore-wings. On the ventral surfaces of both fore- and hind-wings the discal cell spot is light red-brown, with a paler centre.

The female (Fig. 15) is similar to the male, but the dorsal surface of both wings is pale yellow with an orange tint near the fore-wing costa. The ventral surfaces are pale yellow with a slight orange tint in the discal cell and costa. The female has a wingspan of 59–61 mm.

The thorax and abdomen of both males and females are covered in long silver hairs and the tips of the abdomens are dusted with yellow scales.

Biology

Imagos were seen flying from altitudes between 50 and 1800 m a.s.l. (Appendix). Despite this, 80% of the encounters registered were made at altitudes between 500 and 1000 m. This coincides with the altitudinal distribution of *G. maderensis*' plant host, *Rhamnus glandulosa* (Fig. 16).

Based on the very limited data currently at our disposal, there seems to be no differences in the life cycle duration at either of the localities where the eggs were collected. The average duration of the combined larval stage was 17.5 days; for the pupal stage this

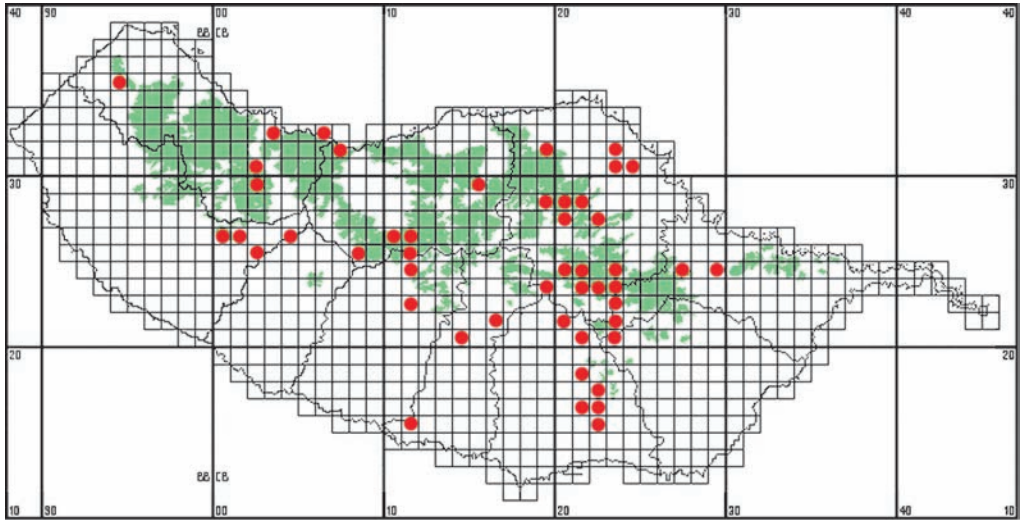


Fig. 16. Distribution of *G. maderensis* and humid laurisilva, of which Macaronesian Buckthorn *Rhamnus glandulosa* is an infrequent component between 500–1000 m in Madeira Island. The map is overlaid with a grid representing 1 × 1 km-squares; locations where specimens were captured or observed are marked with red circles; the green area corresponds to the distribution of humid laurisilva forest.

was 11 days. Together the pre-adult stages lasted on average for 29.3 days (with a minimum of 27 days and a maximum of 32 days).

The number of specimens collected or observed per month (Fig. 17) indicates that this species is univoltine with egg-laying in (or around) June followed by probable death of the egg-producing adults. Egg, larval and pupal development then all takes place around June and July, with no diapause during any of these stages. The next generation of adults is on the wing by July and these fly until November before a winter diapause as adults until January. In the first few months of the year there is sporadic temporary suspension of diapause during periods of good weather. Adult activity increases as summer approaches and the life cycle starts again with egg-laying in or around June. The first half-year peak in observed adult numbers is lower than the peak during the second half of the year. This may be explained by over-winter mortality (i.e. fewer adults are still alive to fly after the winter) and the effects of cooler weather during the first half of the year (i.e. there are fewer days where conditions are suitable for flight).

Discussion

Madeira is an oceanic North Atlantic island, which has probably never had a land link to Africa, its nearest continent. Only species that can survive long distance migration or have been accidentally transported have colonised the island. As the prevailing wind blows down from Europe, the butterfly fauna is essentially European (Wakeham-Dawson et al. 2000). The total fauna comprises about 20 species and the status of some of the taxa is debated. Some authors consider that up to six of these (including *G. maderensis*) are endemic. The other taxa have colonised the island more recently

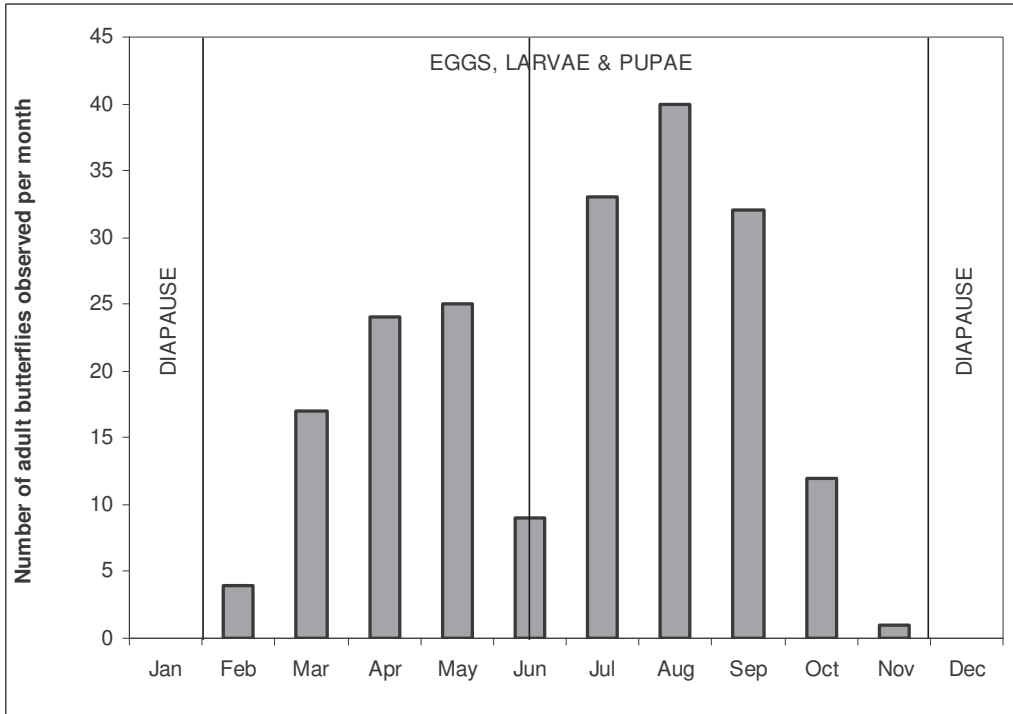


Fig. 17. Number of adult *G. maderensis* specimens captured or observed by month in the period 1932 – 2009 (see Appendix).

and some in very recent history (Wakeham-Dawson et al. 2000). Island populations are particularly sensitive to ecological pressures and one of the taxa, *Pieris brassicae wollastoni* (Butler, 1886), appears to have become extinct in the near past, perhaps as a result of parasite or disease introduction by another species (e.g. Gardiner 2003). Although there is anecdotal suggestion that *G. maderensis* was more common in recent history (e.g. Wakeham-Dawson & Warren 1998), there is no current evidence that it is declining in a similar way to *P. brassicae wollastoni*.

The current study is based on limited data from few eggs and larvae, so until further breeding or rearing studies are carried out it is not possible to make any really conclusive comparisons between *G. maderensis* and other *Gonepteryx* species. However, results of the present study clearly indicate that *G. maderensis* is univoltine with a life cycle not unlike that of *G. rhamni* in Britain and most parts of Europe (Bibby 1983; Ebert & Rennwald 2001; Fartmann 2004). The closely related *G. cleopatra* (L.) is also considered to be univoltine over much of Europe, but has been observed ovipositing on *R. alaternus* leaves as early as 3 March (Athos Peninsula, N. Greece; Wakeham-Dawson, unpublished obs.). However, *G. cleopatra* may over-winter as pupae in northern Africa, and a partial second brood has also been observed in both *G. cleopatra* and *G. rhamni* in that area (Tennent 1996). Another relative, *G. cleobule* (Hübner, 1825) has several named subspecies in the Canary Islands, all of which use *Rhamnus* spp. as host-plants. On these islands, adults have been observed in all months; with

larvae observed in April, August and December. The number of generations per year and the presence of periods of diapause in the life cycle are uncertain. The *G. cleobule* early stages are similar to those of *G. maderensis*, but a published close comparison has not yet been made. In *G. cleobule*, the egg is yellow and has eight longitudinal ribs; the larvae are green with white lateral stripes bordered ventrally by fine yellow lines; the pupa is green with a brown head spine, brown markings at wing origins, many small brown spots across the body and along the outer border of the wing sheath, as well as white lateral stripes (Wiemers 1995). The secreting hairs observed in *G. maderensis* larvae also occur in *Pieris rapae* L., where the fluid consists primarily of a series of chemically labile, unsaturated lipids (mayolenes) that are derived from 11-hydroxylinolenic acid (Smedley et al. 2002). The secretion is a potent deterrent and provides effective defence against a range of predatory arthropods. However, specific parasitoids such as the braconid *Cotesia glomerata* (Linnaeus) seem to use the droplets to effectively locate *P. rapae* larvae for oviposition and are not adversely affected by the secretion (Takabayashi et al. 2000; Shiojiri & Takabayashi 2005). As far as we know, the composition of the *G. maderensis* droplets is unknown. Droplet secretion in this and related *Gonepteryx* species deserves further study.

In *G. rhamni*, larvae disturbed while resting or feeding during any of the larval stages rear up from the host-plant (often from the mid-vein of a *Rhamnus* leaf), holding on only with anal claspers and prolegs until the body is at about 30 degrees (Wakeham-Dawson, unpublished obs.). In this position, the larvae have the appearance of a green twig. *G. rhamni* larvae appear to rest in the day in the mid-rib of a leaf when small and feed at night. Later on, the larger larvae begin to feed in the day, as well as at night. *Gonepteryx maderensis* larvae were observed to be less active during the day than at night. They were not observed to rear up as in *G. rhamni* and the only observed defensive behaviour involved the larvae falling from their host-plant and hanging suspended by a silk tread. Further observations of the *G. maderensis* larvae's defensive behaviour and daily feeding cycle are needed before fuller comparisons can be made.

In the current study, we observed the presence of a *G. maderensis* egg on a food-plant twig. Currently, we have no way of assessing whether this is normal activity or not. *G. rhamni* and *G. cleopatra* generally lay eggs on food-plant leaves, especially buds or younger leaves, allowing the larvae more immediate access to food (Bibby 1983; Ebert & Rennwald 2001; Fartmann, 2004; Wakeham-Dawson, unpublished obs.). Further observations need to be made on oviposition location by *G. maderensis* for comparison with other *Gonepteryx* spp.

This brief study is based on limited data, but it has identified that *G. maderensis* is most probably univoltine. It has described the *G. maderensis* life cycle in detail for the first time and identified gaps in our knowledge that need further research in order to underpin the conservation of *G. maderensis*.

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References

- Bibby, T. J. 1983. Oviposition by the brimstone *Gonepteryx rhamni* (L.) (Lepidoptera; Pieridae) in Monks Wood, Cambridgeshire in 1982. – *Entomologists's Gazette* **34**: 229–234.
- Brunton, C. A., P. J. C. Russell & M. E. N. Majerus 1996. Variation in ultra-violet wing patterns of brimstone butterflies (*Gonepteryx*: Pieridae) from Madeira and the Canary Islands. – *Entomologist* **115**: 30–39, pls A–D.
- Ebert, G. & E. Rennwald 1991. Die Schmetterlinge Baden-Württembergs. Bd. 1, Tagfalter 1. – Eugen Ulmer, Stuttgart. 426 pp.
- Fartmann, T. 2004. Die Schmetterlingsgemeinschaften der Halbtrockenrasen-Komplexe des Diemeltales. Biozönologie von Tagfaltern und Widderchen in einer alten Hudelandschaft. – *Abhandlungen aus dem Westfälischen Museum für Naturkunde* **66** (1): 1–256.
- Gardiner, B. O. C. 2003. The possible cause of extinction of *Pieris brassicae wollastoni* Butler (Lepidoptera: Pieridae). – *Entomologist's Gazette* **54**: 267–268.
- Kudrna, O. 1975. A revision of the genus *Gonepteryx* Leach. – *Entomologist's Gazette* **26**: 3–37.
- Manley, W. B. L. & H. G. Allcard 1970. A field guide to the butterflies and burnets of Spain. – Clasley, Hampton, Middlesex. 192 pp., 40 pls.
- Press, J. R. & M. Short 1994. The flora of Madeira. – HMSO, London. 192 pp.
- Shiojiri, K. & J. Takabayashi 2005. Effects of oil droplets by *Pieris* caterpillars against generalist and specialist carnivores. – *Ecological Research* **20**: 695–700.
- Smedley, S. R., F. C. Schroeder, D. B. Weibel, J. Meinwald, K. A. Lafleur, J. A. Renwick, R. Rutowski & T. Eisner 2002. Mayolenes: labile defensive lipids from the glandular hairs of a caterpillar (*Pieris rapae*). – *Proceedings of the National Academy of Sciences* **99** (10): 6822–6827.
- Takabayashi, J., Y. Sato, S. Yano & N. Ohsaki 2000. Presence of oily droplets from the dorsal setae of *Pieris rapae* larvae (Lepidoptera: Pieridae). – *Applied Entomology and Zoology* **35** (1): 115–118.
- Tennent, J. 1996. The butterflies of Morocco, Algeria and Tunisia. – Gem, Wallingford, Oxfordshire, i–xx, 217 pp.
- van Swaay, C. A. M. & M. S. Warren 1999. Red Data book of European butterflies (Rhopalocera). – *Nature & Environment* no. 99. Strasbourg, 260 pp.
- Wakeham-Dawson, A. & L. Warren 1998. Conservation of butterflies and other endemic species in the Funchal Ecological Park, Madeira. – *British Journal of Entomology and Natural History* **10**: 210–213.
- Wakeham-Dawson, A. & A. M. Franquinho Aguiar 2003. The arrival of a *Cacyreus marshalli* (Butler, 1898) larva, a larval host-plant for *Lycaena phlaeas phlaeoides* (Staudinger, 1901) and notes on other butterfly (Rhopalocera, Lepidoptera) species in the Madeiran Archipelago, Portugal, 8–15 July 2002. – *Entomologist's Gazette* **54**: 227–231.
- Wakeham-Dawson, A., M. Salmon & A. M. Franquinho Aguiar 2000. Field guide to the butterflies of the Funchal Ecological Park and Madeiran Archipelago. – Funchal Municipal Council, Madeira. 115 pp.
- Wakeham-Dawson, A., A. M. Franquinho Aguiar & G. Martin 2002. The distribution of endemic butterflies (Lepidoptera) on the island of Madeira, Portugal, since 1850 with comments on their current conservation status. – *Entomologist's Gazette* **53**: 153–180.
- Wiemers, M. (1995). The butterflies of the Canary Islands. A survey of their distribution, biology and ecology (Lepidoptera: Papilionoidea and Hesperioidea). – *Linneana belgica* **15**: 63–84; 87–118.

Appendix

Adult *G. maderensis* specimens captured or observed on Madeira Island in the period 1932–2009. Key: **UTM** = Universal Transverse Mercator Coordinates; **C** = captured; **O** = observed; **M** = male; **F** = female. See Wakeham-Dawson et al. (2002) for more details. Observations made between 2002 and 2009 are recorded in various papers by the authors or are new observations recorded for the first time in the present paper.

Locality	Altitude	Date	UTM Coordinates	C/O	Adults	M	F
Encumeada	1000	03-07-1932	28SCB1125	O	2		
Rabaçal	1050	17-07/ 4-08-1935	28SCB0026	C	2		
Ribeiro Frio	780	01-09-1954	28SCB2323	C	1	0	1
Ribeiro Frio	780	02-08-1964	28SCB2323	C	1	1	0
Poiso	1000	04-09-1973	28SCB2320	C	1		
Santana	420	13-09-1973	?	C	1		
Encumeada	1000	13-09-1973	28SCB1125	C	25		
Ribeiro Frio	880	07-08-1974	28SCB2323	C	2	2	0
Fajã da Nogueira	600	23-08-1974	?	C	1		
3 km west Poiso	1400	27-05-1905	28SCB2120	C	4		
Fajã da Nogueira	600	6/9-05-1975	?	C	1		
Monte	750	24-08-1975	28SCB2216	C	1		
Pico Alto	1000	24-08-1975	28SCB2118	C	4		
Fajã da Nogueira	1000	26-08-1975	28SCB1125	C	2		
Ribeiro Frio	800	29-08-1975	28SCB2323	C	1		
Encumeada	1000	30-08-1975	28SCB1125	C	1		
Monte	450-650	1975/1976	28SCB2116	?			
Encumeada	1007	1975/1976	28SCB1125	?			
Curral das Freiras	600-700	1975/1976	28SCB1621	?			
Paul da Serra	1450	1975/1976	28SCB0426?	?			
Terreiro da Luta	868	1975/1976	28SCB2217	?			
Ribeiro Frio	800-900	1975/1976	28SCB2323	?			
Pico do Arieiro	1800	1975/1976	28SCB1923	?			
Quinta Grande	600	06-06-1976	28SCB1115	C	1		
Pico das Pedras	900	12-08-1976	28SCB2227	C	3	0	3
Encumeada	1000	07-05-1977	28SCB1125	C	6	4	2
Encumeada	1000	07-05-1977	28SCB1125	C	3		
Ribeiro Frio	750	09-05-1977	28SCB2323	C	2		
Queimadas	880	03-06-1980	28SCB2128	C	1	1	0
Ribeiro Frio	850-900	04-09-1980	28SCB2323	C	1	1	0
Ribeira da Metade	500	??-04-1981	28SCB2324	O	3	0	3
Ribeiro Frio	850-900	??-07-1981	28SCB2323	O	8		
Fajã da Nogueira	500-600	??-08-1981	?	O	2		
Queimadas/C. Verde	880-950	????	?	C	1		
Queimadas/C. Verde	880-950	12-08-1985	?	O	2	2	0

Continuation.

Locality	Altitude	Date	UTM Coordinates	C/O	Adults	M	F
Ribeiro Bonito	500-600	15-08-1985	28SCB1931	O	2		
Balcões	899	21-08-1985	28SCB2323	O	2	2	0
Encumeada	1000	14-06-1993	28SCB1125	C	1		
Levada das 25 Fontes	965	01-06-1996	28SCB0126	O	1		
Chão da Ribeira	600	18-07-1996	28SCB0230	O	4	4	0
Levada do Folhadal	1010	03-05-1997	28SCB0225	O	1	1	
Pináculo	1015	03-05-1997	28SCB0825	O	3	1	2
Estrada Porto da Cruz/ Portela	610	23-09-1997	28SCB2924	O	1	0	1
Chão da Ribeira	450	24-07-1998	28SCB0230	C	1		
Encumeada	600	28-07-1998	28SCB1026	C	1		
Chão da Ribeira	500-600	03&04-1998	28SCB0230	O	1		
Chão da Ribeira	500-600	24-07-1998	28SCB0230	O	1	0	1
P. Ecológ. do Funchal	500-1400	30-07-1998	28SCB2120	O	1	1	0
Ribeiro Frio	850-900	??-07-1998	28SCB2323	O	4		
Encumeada	850-1007	??-07-1998	28SCB1125	O	4		
Ribeiro Frio/Poiso	900-1350	??-07-1998	CB2321+CB2322	O	1		
Recinto da Feira Agro- Pecuária	666	15-07-1999	28SBB9436	O	1	1	0
Estrada S. Vicente/ Encumeada	639	15-07-1999	28SCB1026	O	1	1	0
Vereda Queimadas/ Caldeirão Verde	880-950	05-08-1999	?	O	5	5	0
Chão da Ribeira	500-600	28-02/6-03- 2000	28SCB0230	O	4		
Estrada S. Vicente/ Seixal	100	23-03-2000	28SCB0332	O	1	1	0
Chão dos Louros	795	15-06-2000	28SCB1126	O	1	1	0
Chão da Ribeira	619	28-06-2000	28SCB0229	C	4		
Above Montado do Sabugal	955	10-08-2000	28SCB2124	O	2	2	0
Fajã da Nogueira (near the Central)	610	10-08-2000	28SCB2124	O	1	0	1
Estrada Encumeada/ Rosário	590	24-08-2000	28SCB1026	O	2	1	1
Estrada Encumeada/ Rosário	650	14-09-2000	28SCB1026	O	1	1	0
Estrada Encumeada/ Rosário	424	14-09-2000	28SCB1026	O	1	1	0
Casa do Barreiro, PEF	970	08-03-2001	28SCB2118	O	1	1	0
Ribeiro Frio	850-900	08-03-2001	28SCB2323	O	1	0	0

Continuation.

Locality	Altitude	Date	UTM Coordinates	C/O	Adults	M	F
P. Ecológ. do Funchal	1200-1600	09-03-2001	?	O	2	2	0
Estrada Encumeada/ Rosário	424	14-09-2000	28SCB1026	O	1	1	0
Casa do Barreiro, PEF	970	08-03-2001	28SCB2118	O	1	1	0
Ribeiro Frio	850-900	08-03-2001	28SCB2323	O	1	0	0
P. Ecológ. do Funchal	1200-1600	09-03-2001	?	O	2	2	0
Encumeada	1000	7/10-03-2001	28SCB1125	O	4		
Posto Florestal, Lamaceiros, Portela	840	7/10-03-2001	28SCB2724	O	4		
Achada do Teixeira to Queimadas	1330	12-08-2001	28SCB2027	O	2	2	0
Pico das Pedras (Park Entrance)	887	12-08-2001	28SCB2227	O	1	1	0
Encumeada	800	27-09-2001	28SCB1115	O	1	1	0
Encumeada	800	8/12-10-2001	28SCB1125	O	12	11	1
Chão da Ribeira	500-600	22-04-2002	28SCB0229	O	16	8	8
Fajã da Nogueira (before the Power station)	625	14-05-2002	28SCB2123	O	2	1	1
Fajã da Nogueira (before the Power station)	625	14-05-2002	28SCB2123	O	1	1	0
Montado do Sabugal	840	14-05-2002	28SCB2024	O	1	1	0
Risco Fall, Rabaçal	1200	09-07-2002	28SCB0126	O	1	1	0
Ribeiro Frio	850-900	14-07-2002	28SCB2323	O	1	0	1
Encumeada	1000	10/17-04-2003	28SCB1125	O	1	1	0
Posto Florestal, Lamaceiros, Portela	840	10/17-04-2003	28SCB2724	O	1	1	0
Chão da Ribeira	500-600	10/17-04-2003	28SCB0229	O	1	1	0
Sao Vincente	50	10/17-04-2003	CB0632+CB0731	O	2	1	1
Lombo do Urzal, Boaventura	370	05-02-2004	28SCB1529	O	1	1	0
Levada da Central da Serra de Água	598	19-02-2004	28SCB1124	O	2	1	1
Levada do Bom Sucesso	200	18-03-2004	28SCB2215	O	1	1	0
Boca da Corrida	1193	26-07-2004	28SCB1420	O	1	1	0
Terra Grande, Serra de Água	440	25-11-2004	28SCB1122	O	1	1	0
Poiso/Pico do Arieiro	1590	04-08-2006	28SCB2021	O	1	1	0
Boca da Corrida	1235	07-08-2006	28SCB1420	O	1	1	0
Ribeiro Frio	899	23-04-2009	28SCB2323	O	2	1	1